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## (54) AUTOMATIC HEADLAMP LEVELLING


(71) We, SOCIETE POUR L'EQUIPMENT DE VEHICULES, a French Body Corporate of 26 Rue Guynemer, 92132 Issy-Les-Moulineaux, France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—


When an automobile vehicle moves along a roadway at night it is desirable to illuminate the roadway in front of the vehicle over a distance sufficient to ensure safe driving, but only over a distance which is limited to obtain best use of the power of the headlamps for the needs of the driver and with the least possible dazzling of the drivers of oncoming vehicles. To achieve this object is has already been proposed that, during displacement of the vehicle, the headlamps be rotated about an axis substantially parallel to the roadway to maintain substantially constant the distance L between the vehicle and the point of intersection of the axis of each road-illuminating beam with the supposedly horizontal roadway. Of course, when the vehicle is loaded so as to shift the centre of gravity forwards or rearwards with respect to the "empty vehicle" centre of gravity position. These variations of loading occur at rest and when driving (accelerating or decelerating) and become evident as a variation of the position of centre of gravity with the roadway, hereinafter called an 'inertia' variation and/or by a variation of inclination of the vehicle with respect to the roadway, hereinafter called an attitude variation.

It has already been proposed, for example in French Patent No. 6,937,513, to provide an adjustment device correcting for variations of inclination of the vehicle, that is to say of "attitude variations" of the said vehicle. To do this, it has been proposed to detect the position of the chassis with respect to the ground by means of sensors disposed near the front and rear axles of the vehicle. If $d_1$ denotes the height of the chassis above the ground at a point $P_1$ near the front sensor and $d_2$ denotes the height of the chassis above the ground at a point $P_2$ near the rear sensor, and if the angle $\gamma$ denotes an angle of attitude of the headlamp with respect to the vehicle, the prior art system effects a control such that the angle $\gamma$ has a value of the formula

$$\gamma=k(d_2-d_1)+k',$$

in which formula k and k' are constants.

Such a type of control takes into account the variation of inclination of the vehicle but does not take account of the above-mentioned "inertia variations". The control thus obtained was insufficient and it is thus desirable to improve the characteristics of said control. The object of the present invention is to provide a control with considerable improvement of the constancy of the distance L mentioned above.

Since the height of the vehicle above the road can be detected by means of the expression

$$\frac{d_1+d_2}{2}$$

the angle $\gamma$ defined above then takes the value:

$$\gamma=k(d_2-d_1)+k'+k''(d_2+d_1)$$

where k'' is a constant.

According to one aspect of the present invention, there is provided a process for controlling the attitude of an automobile vehicle headlamp with respect to the chassis, said headlamp being capable of pivoting about an axis substantially parallel to the roadway and having its position defined by an angle $\gamma$, such process comprising: using at least one sensor in the vicinity of the front wheels and at least one sensor in the vicinity of the rear wheels, responsive to the respective heights $d_1$ and $d_2$ of the chassis above the roadway at points

$P_1$ and $P_2$ of the chassis, where the point $P_1$ is at a distance $l_1$ from the axis of rotation of the headlamp and at a distance $l_2$ from the point $P_2$ and the distances $l_1$ and $l_2$ are measured as horizontal projections on the line $P_1P_2$; and maintaining the headlamp angle $\gamma$ equal to or in the region of $\gamma_0$, where

$$\gamma_0=k_1(d_2-d_1)+k_2d_1+k_3,$$

and $k_1$, $k_2$ and $k_3$ are constants with $k_1$ and $k_2$ in the relationship

$$k_1l_2+k_2l_1\simeq l.$$

The very noticeable improvement obtained, when controlling a vehicle by the process of the present invention has been found to permit the distance L to be maintained constant to within 2%, (L being in general of the region of 75 metres) during all conditions of acceleration and manoeuvring of the test vehicle.

The accuracy of control depends upon the values of the parameters $l_1$ and $l_2$ and the constants $k_1$ and $k_2$. In practice the constants $k_1$ and $k_2$ can be kept such that the expression $k_1l_2+k_2l_1$ has a value of from 0.9 to 1.1, but the nearer the value of this expression is to unity, the better the control. Of course, in this relationship, the lengths $l_1$ and $l_2$ are expressed in the same units.

For the process of the invention, maintenance of the value of $\gamma$ at the value $\gamma_0$ expressed above can be effected by any suitable means, that is to say either by a manual control apparatus or by an automatic control device. In the case of manual control, the driver may for example adjust a first indicator, whose position is a function of $\gamma$, for coincidence with a second indicator, whose position is a function of $\gamma_0$, this second indicator being controlled automatically by way of signals provided by the sensors $C_1$ and $C_2$. In the case of automatic control, the angle $\gamma$ can be maintained equal to $\gamma_0$ by means of a mechanical, hydraulic, electric or other device.

However another aspect of the present invention provides an automatic control device for controlling the attitude of an automobile vehicle headlamp, this device comprising at least one sensor near the front wheels of the vehicle and at least one sensor near the rear wheels; means for driving the headlamp for pivoting about an axis substantially parallel to the roadway with an attitude angle $\gamma$ with respect to the chassis; a calculator member which from signals responsive to heights $d_1$ and $d_2$ of the chassis above the road as measured by the front and rear sensors, respectively, provides a voltage $V_1(\gamma_0)$; a signal member providing a voltage $V(\gamma)$ as a function of the attitude angle $\gamma$ of each headlamp, $V(\gamma)$ being equal to $V_1(\gamma_0)$ when

$$\gamma=\gamma_0=k_1(d_2-d_1)+k_2d_1+k_3$$

with

$$l_2k_1+l_1k_2\simeq l;$$

and a control member acting in response to the difference $V(\gamma)-V_1(\gamma_0)$ to actuate said headlamp driving means to nullify said difference.

In this definition of the device according to the invention, the symbols $k_1$, $k_2$, $k_3$, $l_1$, $l_2$, $d_1$, $d_2$ have the meanings given above in the definition of the process.

In one preferred embodiment, the calculator member comprises an electronic circuit receiving, from the sensors $C_1$ and $C_2$, voltages which are responsive to $d_1$ and $d_2$ and are proportional to $d_1$ and $d_2$. The signal member is a potentiometer adjusted by a member linked to the headlamp. The voltages $V(\gamma)$ and $V_1(\gamma_0)$ are fed to a component subtractor whose output feeds the control members by way of an amplifier. The control member is an electric motor driving the headlamp for pivoting about its rotation axis.

It is possible to ensure, for such a device, a limit zone of functioning. In particular, if it is desired that the angle $\gamma$ should stay between two limits, the control member can be locked once the voltage $V(\gamma)$ has attained one of the two limits between which it is to be maintained. In such a case, the device may further comprise a locking member associated with the signal member, said locking member receiving a voltage as a function of $\gamma$, comparing said voltage with at least one predetermined threshold and stopping functioning of the control member when one of said thresholds is infringed.

It is clear that the control device according to the invention can ensure simultaneous control of the two headlamps of the vehicle. However a respective control loop for each of the headlamps of the automobile vehicle can be used. In this latter case, the device may advantageously comprise a single calculator member which provides the same voltage $V_1(\gamma_0)$ to the two separate identical control loops, each loop controlling the position of a respective one of the vehicle headlamps.

The present invention finally provides the novel industrial product which constitutes an automobile vehicle comprising at least one front headlamp which is capable of pivoting about an axis substantially parallel to the roadway, and is controlled by the control device of the second aspect of the invention.

In order that the invention may be better understood, there will now be described,

merely by way of example, one embodiment of self-levelling headlamp control system shown on the accompanying drawing, in which:—

Figure 1 represents schematially a vehicle comprising two sensors $C_1$ and $C_2$, this schematic diagram showing the parameters which are involved in the process according to the invention; and

Figure 2 is a block schematic diagram of an automatic control device using the process of the invention.

The drawing shows a vehicle 1 which, according to the invention, is equipped with two identical headlamps 2 mounted for pivoting about a transverse axis 3 parallel to the roadway 4. In their pivoting movement, the attitude of the two headlamps 2 is defined with respect to the chassis by an angle $\gamma$. The axis of the illuminating beam of each headlamp 2 intersects the roadway at a point A which, in horizontal projection is spaced by a distance L from the axis 3. The vehicle carries a sensor $C_1$ near the front wheels and a sensor $C_2$ near the rear wheels. In the example described, the points $P_1$ and $P_2$ are coincident with the positions of the sensors $C_1$ and $C_2$. The sensors $C_1$ and $C_2$ provide d.c. voltages which are, respectively, proportional to the heights $d_1$ and $d_2$ of the vehicle chassis above the roadway at the respective zones of the sensors $C_1$ and $C_2$. As projection onto the line $P_1P_2$, $l_1$ denotes the distance of the sensor $C_1$ from the axis 3 and $l_2$ denotes the distance between the two sensors $C_1$ and $C_2$.

As shown in the schematic block diagram of Figure 2, the control device comprises a calculator member 5 which receive on its two inputs 6 and 7 the voltages delivered by the sensors $C_1$ and $C_2$ respectively. From these voltages, the calculator member generates a voltage $V_1$ as a function of $\gamma_0$, where $\gamma_0$ is a parameter defined by the two following equations:

$$\gamma_0=k_1(d_2-d_1)+k_2d_1+k_3,$$

and

$$l_2k_1+l_1k_2=1$$

where $k_1$, $k_2$ and $k_3$ are constants, and $l_1$, $l_2$, $d_1$, $d_2$ have the meanings indicated above. The headlamps 2 are associated with a signal member in the form of a potentiometer which delivers a voltage V as a function of the value of the angle $\gamma$ at that instant. The voltage $V_1(\gamma_0)$ is the value of voltage $V(\gamma)$ when $\gamma=\gamma_0$. The output of the calculator member 5 and that of the signal member 8 are applied to a component subtractor 9 which feeds an amplifier 10, whose output drives the control member 11. The control member 11 is for example an electric motor capable of turning in either direction; this motor drives the associated headlamp 2 for pivoting in the two directions. The choice of gain for the amplifier 10 in the control loop thus constituted is determined by design such that the control remains stable.

Whatever the loading changes of a vehicle and whatever the driving variations and attitude variations due to accelerations or to fierce applications of braking, with a device of this type a distance L equal to 75 metres can be maintained to within a tolerance of 2%. This result is a considerable improvement with respect to the devices of the prior art which, in general, only permit the distance L to be maintained constant with an accuracy of about 20%.

WHAT WE CLAIM IS:—

1. A process for controlling the attitude of an automobile vehicle headlamp with respect to the chassis, said headlamp being capable of pivoting about an axis substantially parallel to the roadway and having its position defined by an angle $\gamma$, such process comprising: using at least one sensor in the vicinity of the front wheels and at least one sensor in the vicinity of the rear wheels responsive to the respective heights $d_1$ and $d_2$ of the chassis above the roadway at points $P_1$ and $P_2$ of the chassis, where the point $P_1$ is at a distance $l_1$ from the axis of rotation of the headlamp and at a distance $l_2$ from the point $P_2$ and the distances $l_1$ and $l_2$ are measured as horizontal projections on the line $P_1P_2$; and maintaining the headlamp angle $\gamma$ equal to or in the region of $\gamma_0$, where

$$\gamma_0=k_1(d_2-d_1)+k_2d_1+k_3,$$

and $k_1$, $k_2$ and $k_3$ are constants with $k_1$ and $k_2$ in the relationship

$$k_1l_2+k_2l_1\simeq 1.$$

2. A process according to Claim 1, wherein the value of $\gamma$ is maintained at, or in the region of, the value $\gamma_0$ by a manual control device enabling a driver or other operator to ensure coincidence of a first indicator, whose position is a function of $\gamma$, with a second indicator whose position is a function of $\gamma_0$, this second indicator being controlled automatically by way of signals provided by the front and rear sensors.

3. A process according to Claim 1, wherein an automatic control device maintains the value of $\gamma$ at, or in the region of, the value $\gamma_0$.

4. An automatic control device for controlling the attitude of an automobile vehicle headlamp, this device comprising at least one sensor near the front wheels of the vehicle and at least one sensor near the rear wheels; means for driving the headlamp for

pivoting about an axis substantially parallel to the roadway with an attitude angle $p$ with respect to the chassis; a calculator member which from signals responsive to heights $d_1$ and $d_2$ of the chassis above the road as measured by the front and rear sensors, respectively, provides a voltage $V_1(p_0)$; a signal member providing a voltage $V(p)$ as a function of the attitude angle $p$ of each headlamp, $V(p)$ being equal to $V_1(p_0)$ when

$$p=p_0=k_1(d_2-d_1)+k_2d_1+k_3$$

with

$$l_2k_1+l_1k_2\simeq l;$$

and a control member acting in response to the difference $V(p)-V_1(p_0)$ to actuate said headlamp driving means to nullify said difference; where $k_1$, $k_2$, $k_3$, $l_1$, $l_2$ have the meanings defined in Claim 1.

5. A device according to Claim 4, wherein the calculator member comprises an electric circuit receiving from the front and rear sensors voltages responsive to $d_1$ and $d_2$.

6. A device according to Claim 5, wherein the voltages fed to the calculator member by the front and rear sensors, respectively, are directly proportional to $d_1$ and $d_2$.

7. A device according to any one of Claims 4 to 6, wherein the signal member is a potentiometer moved by an element connected to the headlamps.

8. A device according to any one of Claims 4 to 7, wherein the voltages $V(p)$ and $V_1(p_0)$ are fed to a component subtractor whose output feeds the control member by way of an amplifier.

9. A device according to any one of Claims 4 to 8, wherein the headlamp driving means is an electric motor permitting pivoting of the headlamp about its axis of rotation.

10. A device according to any one of Claims 4 to 9, and including a locking member associated with the signal member, said locking member receiving a voltage proportional to $p$, comparing said voltage with at least one predetermined threshold and disenabling the control member when there has been an infringement of one of said thresholds.

11. A device according to any one of Claims 4 to 10, when connected to ensure simultaneous control of the two front headlamps of an automobile vehicle.

12. A device according to any one of Claims 4 to 10, comprising a control loop for each of the headlamps of the automobile vehicle.

13. A device according to Claim 12, wherein there is a single calculator member which provides the same voltage $V_1(p_0)$ to the two separate control loops each controlling the position of one of the headlamps of the vehicle.

14. An automatic control device for controlling the attitude of an automobile vehicle headlamp, such device being constructed and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

15. An automobile vehicle comprising at least one front headlamp capable of pivoting about an axis substantially parallel to the roadway, said headlamp being controlled by a device according to one of Claims 4 to 14.

16. A process for controlling the attitude of an automobile vehicle headlamp with respect to the chassis such process being substantially as hereinbefore described with reference to the accompanying drawings.

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FIG.2

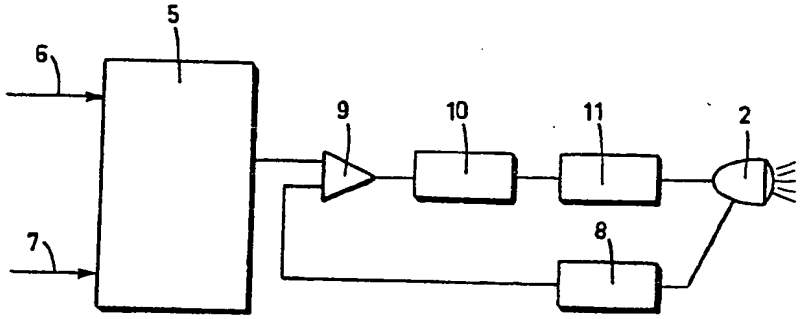


FIG.1